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Effect of soil applied granular insecticides on soil chemical properties in sugarcane ecosystem

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Abstract
A field experiment was conducted at Main Sugarcane Research Station Farm of Navsari Agricultural University, Navsari. Four treatment of insecticides *viz*. T_0 Control, T_1 Phorate 10G (1.5 kg a.i./ha), T_2 Carbofuran 3G (1 kg a.i./ha), T_3 Chlorantraniliprole 0.4G (0.1 kg a.i./ha) were taken and applied at 60 days after planting. The soil samples were periodically collected at 1, 3, 5, 10, 20, 30, 60 days after application of insecticides and at the time of harvest. The application of insecticides didn't produce any significant effect on periodic soil pH, electrical conductivity, organic carbon and K_2O content of soil. The available nitrogen was significantly higher in treatment of phorate and remained statistically at par with treatment of carbofuran and chlorantraniliprole. In case of days after application, available N was significantly higher at 60 days after application but remained statistically at par with available N content at 30 days after application of insecticides. The soil applied insecticides didn't exert any significant effect on available P_2O_5 content in soil. The available P_2O_5 content was found significantly higher in the soil at 3 days and 30 days after application of insecticide but remained statistically at par with P_2O_5 content at 5 days and 60 days after application of insecticides.

Keywords: carbofuran, chemical properties, chlorantraniliprole and phorate

1. Introduction
Sugarcane is the one of important cash crop of India with the second highest production of sugar after Brazil. Like other important annual crops of economic importance, lot of factors are responsible for the lower productivity of sugarcane in India. Among these Insect-pests are the important constraints accounting a significant loss in sugarcane yield and sugar recovery, resulted a large amount annual revenue loss each year. Sugarcane crop is also subjected to infest by borer and white grub causing widespread damage to underground stem and root. For control or management of these insect-pests, soil applied granular form of insecticides especially phorate, carbofuran and chlorantraniliprole are extensively used throughout the country in sugarcane grown areas.

The main problem associated with the growth and development of agriculture field is the use of fertilizers and pesticides throughout the country. Although, this use of chemicals in agriculture sector has produced a significant benefit for increasing yield and productivity of crop. It is also interesting to notice that pesticides frequently used in modern agriculture but their comparative residual effects on availability of nutrients in soil have rarely reported (Das and Mukherjee, 1994) [3]. Residues of pesticides in soil are generally degraded and their degraded products are assimilated by soil microorganisms resulted in increasing microbial population and activities in soil which influences the transformation of plant nutrients in soil (Das and Mukherjee, 2000) [4]. Therefore, considering these facts this experiment was conducted to determine the effect of soil applied granular insecticides on soil chemical properties in sugarcane ecosystem.

2. Materials and Methods
A field trial was conducted during 2016-17 at Main Sugarcane Research Station Farm of Navsari Agricultural University, Navsari, Gujarat. The soil of experimental field was clay in texture having $pH_{2.5}$ 7.7, $EC_{2.5}$ 0.48 dS/m and organic carbon 0.68%. The soil was medium in available N (258 kg/ha) and available P_2O_5 (46 kg/ha) and high in available K_2O (380 kg/ha). Four treatment of soil applied granular insecticides *viz*. T_0 Control, T_1 Phorate 10G (1.5 kg a.i./ha), T_2 Carbofuran 3G (1 kg a.i./ha), T_3 Chlorantraniliprole 0.4G (0.1 kg a.i./ha) were taken under randomized block design with six replications.

Treatment wise required quantity of insecticide granules (Phorate 15 kg/ha, Carbofuran 33 kg/ha and chlorantraniliprole 25 kg/ha) were mixed thoroughly with dry sand of very fine texture and uniformly distribute in the gross plot at 60 days after planting of sugarcane. Soil sampling was started at 60 days after planting. Treatment wise periodic soil samples were taken from 0-15 cm depth for the study and carried out at the laboratory. Further the samples were processed for analysis of soil chemical properties. The standard method adopted for analysis of soil chemical properties are given in table 1.

Table 1: Standard method adopted for analysis of soil properties

Properties	Methods	References
pH	Potentiometric	Jackson (1967) [5]
EC	Conductometric	Jackson (1967) [5]
Organic C	Walkey and Black (Modified)	Jackson (1967) [5]
Available N	Alkaline $KMnO_4$	Subbiah and Asija (1956) [8]
Available P	Olsen	Olsen, *et al*. (1954) [6]
Available K	Neutral normal ammonium acetate	Jackson (1967) [5]

The periodic data regarding soil chemical properties were statistically analyzed by split plot design considering treatments as main plot and time period as sub plot (Panse and Sukhatme, 1967) [7].

3. Results and Discussion

There is no doubt that use of pesticides in agriculture improved the agricultural productivity many folds but availability of information about the effect of pesticides on soil chemical properties are very rare. It is interesting to note that insecticides frequently applied in modern agriculture, but their comparative residual effects on available nutrient under a particular soil conditions have rarely been reported (Das and Mukherjee, 1994) [3].

Soil pH and EC: An appraisal of the data presented in table 2 and 3 revealed that soil pH and EC were not affected significantly either by insecticides application (I) or days after application (D) or their interactions (I x D). These results of soil pH and electrical conductivity are might be due to high buffering capacity of black soil and uniform native salt content of experimental soil.

Soil organic carbon: The application of insecticides were failed to exert any significant effect on periodic soil organic carbon in sugarcane grown soil (Table 4). The soil organic carbon varied from 0.72 to 0.73 and 0.71 to 0.74 in case of application of insecticides and days after application, respectively.

Available nitrogen: It was observed that there was an increase in available N content in the insecticide treated soils as compared to insecticide untreated soil. Among the insecticides, phorate treated soil has higher available N as compared to carbofuran and chlorantraniliprole treated soil (Table 5) These results are might be due to higher microbial population in insecticide treated soil and most of nitrogen in soil is found in organic form so mineralization of N increases due to microbial activity. It is evident from correlation study, that microbial population is positively correlated with organic C and available N content in soil (Table 8). Das and Mukherjee (1994) [3] also reported the increase in N availability and higher mineralization of N with the incorporation of insecticides. The phorate was more effective as compared to carbofuran in contributing to the higher value of available N content (Borker *et al*., 2018[a]) [1] due to higher stimulation of microbial activity which in turn influences the transformation of plant nutrient element in soil. At the time of harvest of sugarcane, available form of N in soil was lowest. This might be due to the fact that soils are percolative in nature and leaching, volatilization and denitrification losses of N. The nitrogen uptake by the plants can be another reason for decline in N content of soil.

Available phosphorus: The periodic available P_2O_5 show the non significant effect but was found higher in insecticides treated soil as compared to control. Among the insecticides phorate treated soil has higher available P_2O_5 as compared to carbofuran and chlorantraniliprole treated soil (Table 6). The higher P_2O_5 content in insecticide treated soil might be due to higher microbial population. It is also evident from correlation study, that microbial population is positively correlated with organic C and available P_2O_5 content in soil (Table 8). Similar finding were also reported by Borker *et al*. (2018[b]) [2] in different types of soils. The decline in available P_2O_5 content in the soil with the time was might be due to adsorption and fixation of phosphorus in soil complex.

Available potassium: The data presented in table 6 revealed that soil available K_2O was not affected significantly either by insecticides application or days after application (Table 7). The non significant effect of insecticides on available K_2O might be due to less influence of microbial activity on K_2O availability in soil because organic forms of potassium in soils are very less.

4. Conclusion

Treatments of insecticides didn't affect the soil pH, EC, organic carbon, available P_2O_5 and K_2O content in soil. Available N content in the insecticide treated soils was higher as compared to insecticide untreated soil. Among the insecticides phorate treated soil has higher available N as compared to carbofuran and chlorantraniliprole treated soil.

Table 2: Effect of insecticides on periodic soil $pH_{1:2.5}$ in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	7.64	7.60	7.64	7.63	7.63
3	7.68	7.67	7.60	7.65	7.65
5	7.67	7.65	7.75	7.62	7.67
10	7.61	7.62	7.64	7.66	7.63
20	7.71	7.62	7.71	7.58	7.65
30	7.69	7.70	7.65	7.67	7.68
60	7.68	7.68	7.69	7.66	7.68
At harvest	7.68	7.67	7.69	7.64	7.67
Mean	7.67	7.65	7.67	7.64	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	0.01		0.02		0.03
CD at 5%	NS		NS		NS
CV %	0.66		0.58		

*CAP: Chlorantraniliprole

Table 3: Effect of insecticides on periodic soil $EC_{1:2.5}$ (dS/m) in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	0.46	0.45	0.46	0.42	0.45
3	0.50	0.47	0.51	0.45	0.48
5	0.53	0.41	0.42	0.50	0.46
10	0.42	0.45	0.42	0.46	0.44
20	0.41	0.51	0.46	0.38	0.44
30	0.42	0.44	0.54	0.46	0.46
60	0.44	0.39	0.41	0.44	0.42
At harvest	0.41	0.41	0.42	0.41	0.41
Mean	0.45	0.44	0.45	0.44	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	0.02		0.02		0.03
CD at 5%	NS		NS		NS
CV %	14.35		10.52		

*CAP: Chlorantraniliprole

Table 4: Effect of insecticides on periodic soil organic carbon (%) in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	0.72	0.71	0.68	0.71	0.71
3	0.70	0.76	0.75	0.74	0.74
5	0.74	0.69	0.70	0.69	0.71
10	0.73	0.71	0.68	0.73	0.71
20	0.75	0.74	0.75	0.74	0.74
30	0.77	0.71	0.72	0.72	0.73
60	0.71	0.71	0.74	0.74	0.73
At harvest	0.70	0.74	0.73	0.73	0.72
Mean	0.73	0.72	0.72	0.72	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	0.01		0.01		0.02
CD at 5%	NS		NS		NS
CV %	7.54		4.73		

*CAP: Chlorantraniliprole

Table 5: Effect of insecticides on periodic available nitrogen (kg/ha) content in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	344	389	377	379	372
3	341	394	385	375	374
5	360	442	392	371	391
10	353	383	379	361	369
20	352	373	368	362	364
30	398	444	422	440	426
60	405	447	429	427	427
At harvest	299	311	297	304	303
Mean	356	398	381	377	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	5.28		6.27		12.54
CD at 5%	23.76		18.16		NS
CV %	5.58		4.69		

*CAP: Chlorantraniliprole

Table 6: Effect of insecticides on periodic available P_2O_5 (kg/ha) content in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	65	70	69	66	67
3	67	75	72	70	71
5	66	72	70	72	70
10	65	70	67	67	67
20	59	70	70	70	67
30	65	75	70	73	71
60	62	74	71	68	69
At harvest	43	53	47	45	47
Mean	62	70	67	66	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	1.16		1.35		2.70
CD at 5%	NS		3.92		NS
CV %	7.00		5.78		

*CAP: Chlorantraniliprole

Table 7: Effect of insecticides on periodic available K_2O (kg/ha) content in sugarcane grown soil

Days after application (D)	Insecticides (I)				Mean
	Control	Phorate	Carbofuran	*CAP	
1	319	337	327	330	328
3	308	318	308	338	318
5	291	302	322	313	307
10	298	300	298	315	303
20	323	334	312	323	323
30	325	325	310	325	321
60	311	309	307	305	308
At harvest	306	319	325	311	315
Mean	310	318	314	320	
	Main plot (I)		Sub-plot (D)		I X D
S.Em±	9.99		9.39		18.78
CD at 5%	NS		NS		NS
CV %	12.67		8.42		

*CAP: Chlorantraniliprole

Table 8: Correlation between microbial population and chemical properties of soil

Insecticide	Correlation coefficient (r)					
	pH	EC	OC	N	P_2O_5	K_2O
Bacteria	0.74	-0.26	0.36	0.90*	0.86*	-0.14
Actinomycetes	0.69	-0.21	0.44	0.84*	0.74	-0.42
Fungus	0.65	-0.26	0.46	0.83*	0.78*	-0.26

* Level of 5% significant

5. References

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